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Growth of Avocado Seedlings

Individual plants vary in susceptibility to injury by concentrations of sodium or potassium in soil

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Avocado seedlings are very sensitive to high sodium or potassium concentrations in the soil, according to observations obtained in studies on the effects of various soil chemical properties on the growth of avocado seedlings.

Seedlings of the Topa Topa variety of avocado were used in the studies— planted in three-gallon containers of Yolo loam soil. The plants were fertilized with nitrogen, phosphorus, and manganese.

Yolo loam used in the study has a medium adsorptive capacity for bases— or cations, the positively charged ions— such as calcium, magnesium, potassium, sodium, and hydrogen. These cations are rather loosely held by the soil colloids— clay and humus. They can be utilized by plant roots and are easily replaced or exchanged by treating the soil with other cations. Therefore, they are called exchangeable cations. From the point of view of soil chemical and physical properties—and plant growth relationships— they are very important soil constituents.

Soil Constituents Vary

Agricultural soils, either naturally or as a result of fertilization and management practices, may vary considerably in the percentages of exchangeable calcium, magnesium, potassium, sodium, hydrogen, and occasionally ammonium. Ordinarily, ammonia is quickly oxidized to nitrates by soil bacteria. If the soil becomes sufficiently acid, however, the bacteria that utilize ammonia as energy material are unable to function and ammonia will accumulate in the exchange complex.

If a soil is low in potassium, and it is not added to the soil in manures or inorganic fertilizer, the exchangeable potassium in the soil is apt to be low. On the other hand, if manure or inorganic potassium—or both—are applied to the soil every year the exchangeable potassium may be built up to rather high levels. In a similar manner irrigation water high in sodium or the continuous use of a fertilizer containing sodium may increase the exchangeable sodium in soil. Some soils contain excess calcium and magnesium in the form of lime or carbonates and bicarbonates. Others naturally low in bases may become acid through repeated application of acidifying fertilizers without corrective gypsum or lime applications.

In these studies, excess carbonates and exchangeable bases were removed from the Yolo loam by leaching with acid. Excess salts were removed by leaching with distilled water. The process gave a soil containing mostly hydrogen in the exchange complex. Depending upon the treatment, all or some of the exchangeable hydrogen was replaced by adding the desired cations as carbonates or bicarbonates. The treated soil was moistened and incubated for two months. The Topa Topa seedlings were watered with distilled water and were grown for four months. At this time the dry weights and chemical composition of tops and roots were obtained.

Seedling Growth

The seedlings grew best at concentrations of 4% to 6% exchangeable potassium and in soils with very low sodium percentages. Growth was not significantly different in an acid soil, a base saturated soil, and a soil containing up to 2% excess lime.

Potassium at 13% and sodium at 4% to 7% reduced growth. Leaves of the seedlings in the 13% potassium soils had a slight potassium burn while those in the 25% soils were moderately to severely burned. The potassium burn was characterized by a scorching or necrosis of the edges and tip of the leaves.

As little as 4% exchangeable sodium produced a moderate sodium burn on the leaves of two out of five seedlings. Sodium at 7% caused moderate to severe leaf injury on all five seedlings. Sodium at 14% killed three seedlings and prevented the growth of two, while 26% sodium killed all the plants.

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Effect of Various Exchangeable Cation Ratios on Growth of Avocado Seedlings in Yolo Loam Soil

Series	Treatment number	Exchangeable cations					Calcium carbonate	pH of soil paste	Dry wt. per pot
		Calcium	Magnesium	Potassium	Sodium	Hydrogen			
		%	%	%	%	%	%		gm.
Potassium	1	86	4	1	< 1	9	0	6.4	10
	2	76	13	6	< 1	5	0	6.6	18
	3	69	13	13	< 1	5	0	6.8	9
	4	50	13	25	< 1	10	0	7.2	6
Sodium	5	76	13	6	< 1	5	0	6.6	18
	6	73	10	6	4	7	0	6.8	14
	7	69	10	6	7	8	0	7.1	12
	8	60	10	6	14	10	0	7.3	3*
	9	50	7	5	26	12	0	7.7	dead
Hydrogen	10	54	6	4	< 1	36	0	5.2	15
	11	68	8	5	< 1	19	0	6.0	17
	12	76	13	6	< 1	5	0	6.6	18
	13	81	13	6	< 1	0	0.5	7.2	15
	14	81	13	6	< 1	0	2.0	7.5	16
Original soil	15	79	14	6	1	0	–	7.7	14

* Three out of 5 plants died. The other two remained alive but did not grow.

Effect of Various Exchangeable Cation Ratios on Chemical Composition of Avocado Seedling Leaves

Series	Treatment	Nitrogen	Calcium	Magnesium	Potassium	Sodium	Phosphorus	Sulfur	Chlorine	Manganese
		%	%	%	%	%	%	%	%	ppm
Potassium	1	2.9	2.6	.38	1.1	.02	.21	.30	.25	14
	2	2.9	2.2	.63	1.5	.03	.21	.32	.23	14
	3	3.0	2.3	.62	3.8	.05	.18	.26	.30	17
	4	3.3	0.8	.48	5.5	.06	.23	.31	.15	22
Sodium	5	2.9	2.2	.63	1.5	.03	.21	.32	.23	14
	6	3.1	1.7	.55	1.5	.26	.21	.31	.17	17
	7	3.1	1.7	.58	1.7	.50	.23	.25	.13	21
	8*	3.1	1.7	.68	1.9	.33	.23	.41	.08	53
	9		Plants died							
Hydrogen-calcium	10	3.2	2.0	.58	1.5	.02	.23	.34	.19	44
	11	3.0	2.2	.61	1.4	.01	.26	.25	.14	28
	12	2.9	2.2	.63	1.5	.03	.21	.32	.23	14
	13	3.1	2.2	.61	1.5	.01	.23	.24	.11	9
	14	3.0	2.3	.61	1.7	.02	.22	.31	.07	9
Original soil	15	2.6	1.9	.68	2.4	.02	.17	.27	.19	37

* Three plants died. Two remained alive but did not grow.

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Chemical Composition

Leaves of seedlings showing slight to moderate potassium burn contained 3.8% potassium: severely burned leaves contained 5.5%. Leaves of seedlings with slight sodium burn patterns contained .26% sodium while moderate to severe patterns were associated with .50% leaf sodium. Two plants which remained alive—but did not grow—in the 14% sodium soil contained only .33% leaf sodium. Leaf calcium and magnesium were not significantly affected by 14% exchangeable potassium or sodium but were slightly reduced by 25% potassium.

Increasing potassium and sodium percentages increased the manganese content of the leaves while excess lime decreased it. The chemical analysis data for manganese were in agreement with visual observations. The leaves of the seedlings in treatments which contained excess lime, showed slight manganese efficiency patterns, while the seedlings in the potassium and sodium series did not show deficiency patterns.

Tests with other plants have shown that growth of tomatoes, barley, vetch, radishes, lettuce, onions, alfalfa, and carrots is not reduced until concentrations of 30% to 40% or more exchangeable potassium and 20% to 40% sodium are attained. Higher concentrations are necessary for leaf burn.

Studies with citrus plants indicate that, in general, they are slightly more tolerant to these cations than were the Topa Topa seedlings. For example, 14% potassium caused leaf burn of the avocados but did not damage sweet or sour orange seedling leaves.

Recently, a citrus orchard in Orange County which had been interplanted to avocados was observed to show no burn of citrus leaves but leaves of many of the avocado trees exhibited typical sodium burn patterns.

These studies indicate that soil sodium percentage considered low for most plants may be high for avocados. The sodium is quickly adsorbed. Sodium burn patterns began to appear within 10 days to two weeks after planting.

The rather marked variation in severity of sodium or potassium injury indicates that individual plants vary in their susceptibility to sodium injury.

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